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ABSTRACT

This study investigated the relation between the entering characteristics of the 1,210 students who entered the 7 residential teachers' colleges in Jamaica in September 1976 and their subsequent performance in college. There were 41 predictor variables (encompassing biographical data, previous education and work experience, and general and specific performance in public examinations) and 33 criterion variables (specific and average grades in compulsory and optional examination subjects, teaching practice, internship and individual study). The data were analyzed in a series of multiple linear regression analyses in which poor predictors were successively eliminated. It was found that the examination average grade could be most efficiently predicted using a student's number of 0-level passes and the scores on either the English and Mathematics or the Learning Potential entrance examination, giving a multiple correlation of about 0.50 in all courses. Performance on English and Mathematics was best predicted using the corresponding entrance examination score, but performance on other college examinations and on teaching could not be reliably predicted using the data collected. Based on these results, several recommendations are made concerning the selection of students for the new Diploma course introduced in September 1981 and its preliminary year. (Author)

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PREDICTING PERFORMANCE IN JAMAICAN TEACHERS' COLLEGES

Final report of the Teachers' College Validity Study

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ABSTRACT

This study investigated the relation between the entering characteristics of the 1210 students who entered the seven residential teachers' colleges in Jamaica in September 1976 and their subsequent performance in college. There were 41 predictor variables (encompassing biographical data, previous education and work experience, and general and specific performance in public examinations) and 33 criterion variables (specific and average grades in compulsory and optional examination subjects, teaching practice, internship and individual study). The data was analysed in a series of multiple linear regression analyses in which poor predictors were successively eliminated. It was found that the examination average grade could be most efficiently predicted using a student's number of O-level passes and the scores on either the English and Mathematics or the Learning Potential entrance examination, giving a multiple correlation of about 0.50 in all courses. Performance on English and Mathematics was best predicted using the corresponding entrance examination score, but performance on other college examinations and on teaching could not be reliably predicted using the data collected. Based on these results, several recommendations are made concerning the selection of students for the new Diploma course introduced in September 1981 and its preliminary year.

NOTE

Readers who are unfamiliar with multiple linear regression analysis can obtain an adequate understanding of the purpose, results and implications of this study from Section 1.1 and Chapter 3.

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CHAPTER 1 : INTRODUCTION

1.1 Background

Approximately one half of those who apply for entry to the teachers' colleges in Jamaica can be accepted, for the simple reason that there are not sufficient places. Colleges presumably select those students who they judge are most likely to complete the course and become good teachers. In making the selection decision, they rely on data on academic ability (numbers of J.S.C or G.C.E passes and scores on the Entrance Examination), recommendations from the applicant's referees, and impressions gained during an interview. However, apart from certain minimum requirements, no standard procedure is adopted. Some colleges rank applicants on the basis of all three Entrance Examination scores, others use only the Learning Potential; some down-grade students who have taken several sittings to obtain their minimum 5 JSC's; some prefer students with at least one O-level, others feel that JSC students work harder; some ignore referee's recommendations altogether.

There is a good reason for the wide variety of selection procedures: no-one knows for sure how the various entrance qualifications and observable personality characteristics are related to success in training as a teacher. Tutors have their intuitions, but they have no objective basis for placing greater emphasis on certain aspects of a student's profile at the expense of measures which may be more valuable.

Only two research studies have been found which deal with the prediction of success in Jamaican teachers' colleges. Both are out of date and rather limited in scope. Bethel (1) studied small samples of the 1965 and 1966 cohorts at Mico College. He found that practice teaching grades were significantly related to three entrance qualifications: intelligence ($r=0.66$), interview rating ($r=0.29$, 0.32) and number of JSC/GCE passes ($r=0.32$), but not to English or Mathematics entrance scores. On the other hand, only intelligence and Mathematics scores were significantly correlated with internship grades. Bethel also found that length of teaching experiance was positively correlated with practice teaching grades, that women tended to be graded higher than men, and that there was no difference between students from a high school background and those from primary and all-age schools in their teaching practice grades.

Thompson and Hibbert (7) examined the relation between number of JSC/GCE passes and overall performance in the final college examinations in the 1968 cohort of secondary students at Mico College. They found a positive correlation between number of passes and overall performance (r=0.47); students admitted on the basis of their GCE O-level results performed at about two grade points higher than students with only JSCs.

In order to study fully the relation between entry qualifications and performance in and after college, much more is needed than a simple examination of correlations. It is also necessary to find whether the predictors duplicate each other and to what extent; only then can one find the best combinations of entry qualifications to use in predicting performance, and the best weightings to give to each. For this purpose, the statistical technique of multiple linear regression is required, plus the facility to sort cases and try out many different possibilities with relative ease of computation.

The present research project (Teachers' College Validity Study) was therefore established in order tomore fully investigate the relations between the academic qualifications of students admitted to teachers' colleges and their success in college courses (including internship), with the aim of specifying more efficient selection criteria. This study does not consider the role of personality data in student selection, a topic which has been investigated elsewhere (3).

In order to allow the investigation of the large number of possible relations between the several measures of academic ability and the several criteria of success in college, it was considered necessary to collect complete data on one entire cohort of students. The cohort entering in September 1976 into one of the seven residential colleges existing at the time (Bethlehem, Church, Mico, Moneague, St. Joseph's Sam Sharpe and Shortwood) was selected for study. The remaining institutions which prepared teachers (West Indies College, Excelsior Education Centre, JSA, CAST and UWI) were excluded because their course structure, methods of selection and criteria for success differed significantly from those of the seven teachers' colleges.

An earlier report (5) provided a descriptive analysis of the 1976 cohort in terms of their entering characteristics: biographical data, previous educational and work experience, and examination qualifications. The present report deals with the analyses of performance in college and the investigation of the relation between entering characteristics and performance in college. Implications for the new programme introduced since this study was started are also considered.

1.2 Initial screening of college performance data

Data was collected from all students in the cohort on all subjects on which they were examined at the end of their second year (June 1978), together with their individual study and internship grades assessed at the end of their third year (May 1979). Data was also available on Practice Teaching grades awarded during the second year (about March 1978). The numbers of students included from each college are shown in Table 1; these numbers do not agree with the numbers given in the earlier report (5) because some students changed course after entry.

Letter grades were converted to a 10-point numerical scale taking A+ to A- as 9, B+ as 8, B as 7, and so on down to D as 1 and D- or less as 0. An average examination grade was then calculated for each student. For the Preprimary and Primary course students, this was based on the four compulsory subjects (English Language, Mathematics, Education I and Education II) and each student's best two optional subjects; for the Secondary students, it was based on the three compulsory subjects (English Language, Education I and Education II) and the two optional subjects. For the purpose of this exercise, Comprehensive Education, which was taken as a substitute for Education I & II at Mico College, was given a double weighting.

Since the purpose of the exercise was to derive information of general applicability, it was necessary to combine data across different colleges. Two factors hindered this process: some subjects were only studied at one or two colleges, and some subjects which were studied at several colleges were examined separately at each college without a reliable procedure for ensuring equivalent standards. Furthermore, the numbers taking some subjects were too small to produce reliable results. It was therefore decided to restrict the analysis to subjects which had been taken by at least 100 students from at least 3 colleges, and which had been examined using at lease one common paper or a careful standardization procedure. Exceptions were made in order to include Comprehensive Education at Mico College in some analyses and four important Secondary course subjects. The subjects included in the analysis as criterion variables are listed in Table 2. Subjects excluded because of lack of common paper were Religious Education, Physical Education and Environmental studies; subjects excluded because of small numbers were Library Science, Reading, Child Drama, Art, Music & Movement, Spanish, Agricultural Science, Geography, History, Biology, Chemistry, Physics, Home Economics and Industrial Arts, together with some of the subjects mentioned in Table 1 but taken in other courses. Grades on excluded subjects could still be included in the computation of the average grade.

Table 1: Numbers of students in 1976 cohort who took final examinations in 1978 and completed internship in 1979, by course and college

College	Course[a]			Total
	Preprimary	Primary	Secondary	
Bethlehem	24	54	14	92
Church	2	26	72	100
Mico		125	131	256
Moneague	40	187		227
St. Joseph's	77	116		193
Sam Sharpe		141		141
Shortwood	22	82	97	201
Total	165	731	314	1210

[a]24 students also completed a Special Education course at Mico College. Their data are not included in the following analysis.

Table 2: Criterion variables, by course[a]

Preprimary	Primary	Secondary
Eng. Language (182)	Eng. Language (792)	Eng. Language (361)
Mathematics (182)	Mathematics (792)	Mathematics (54)
Education I (182)	Education I (646)	Education I (198)
Education II (182)	Education II (646)	Education II (198)
	Soc. Studies (489)	Soc. Studies (60)
	Gen. Science (476)	Gen. Science (81)
	Art & Craft (150)	Eng. Lit. (90)
	Music (197)	Compr. Educ. (163)
	Compr. Educ. (146)	
Exam. average (182)	Exam. average (792)	Exam. average (361)
Pr. teaching (182)	Pr. teaching (792)	Pr. teaching (361)
Indiv. study (182)	Indiv. study (792)	Indiv. study (361)
Internship (182)	Internship (792)	Internship (361)

[a]Numbers in brackets indicate the numbers of students with data on that variable.

Table 3: Intercorrelations of grades on compulsory subjects (Preprimary course)[a]

Variables	2	3	4	5	6	7	8
1. English Language	18	-03	13	46	18	13	01
2. Mathematics		21	25	60	06	27	16
3. Education I			40	54	-14	23	22
4. Education II				54	11	13	17
5. Exam. Average					20	38	28
6. Practice Teaching						06	35
7. Individual Study							42
8. Internship							

[a]Decimal points omitted. N=165.

1.3 Correlations between college performance grades

For the sake of reference, Tables 3-5 record the correlations between students' examination grades on the compulsory subjects. Data for Mico College students are given separately because they took Comprehensive Education in place of Education I & II.

In the Preprimary and Primary courses, correlations between examination grades tended to be rather low, with a median of 0.23 and an interquartile range from 0.20 to 0.25. Correlations with the examination average grade were naturally rather higher (median 0.56).

In all courses, correlations between examination grades and the teaching grades (Practice Teaching, Individual Study and Internship) were very low; the median was 0.15, with an interquartile range from 0.12 to 0.20. Correlations of the teaching grades with the average examination grade were only slightly higher (median 0.28, interquartile range 0.22 to 0.32).

The only consistently moderate correlations were those of Internship with Practice Teaching and Individual Study (median 0.43, interquartile range 0.40 to 0.53). It must be noted however, that a student's grades in these three subjects depend heavily on the subjective judgement of the same set of college lecturers, so they can hardly be considered to be independent assessments.

These results emphasize the importance of retaining multiple criteria of success in a teachers' college programme. Examination performance appears to bear little relation to performance in the classroom, at least as assessed up to the end of internship. On the other hand, the level of a students' examination performance cannot be ignored, since it is taken into consideration when computing the average grade which appears on a teacher's certificate; it may also play a role in the professional development of the teacher after certification, a criterion which it was impossible to assess in this study. But no one examination subject can be singled out; not even the obvious ones of Language and Education showed consistently high or even moderately high correlations with teaching grades. The two most appropriate criteria would appear to be the Examination average grade and the Internship grade, and we shall therefore consider these as the principal criteria in the regression analysis below.

Table 4: Intercorrelations of grades on compulsory subjects (Primary course)[a]

Variable	1	2	3	4	5	6	7	8
1. English Language		20	24	31	63	12	15	12
2. Mathematics	27		19	25	60	11	23	26
3. Education I	25	23		23	58	05	34	12
4. Education II					55	20	13	19
5. Exam Average	51	57		86		22	35	32
6. Practice Teaching	14	17		18	24		14	30
7. Individual Study	09	14		25	29	29		44
8. Internship	20	12		31	34	40	59	

[a]Decimal points omitted. Entries below the diagonal refer to students from Mico College (N=125); entries above the diagonal refer to the remaining students (N=606).

Table 5: Intercorrelations of grades on compulsory subjects (Secondary course)[a]

Variable	1	3	4	5	6	7	8
1. English Language		45	35	62	15	01	-07
3. Education I			44	75	20	21	22
4. Education II	21			61	17	01	16
5. Exam. Average	58	79			26	20	30
6. Practice Teaching	08	20		27		28	41
7. Individual Study	03	26		36	20		45
8. Internship	-02	23		28	54	53	

[a]Decimal points omitted. Entries below the diagonal refer to students from Mico College (N=130); entries above the diagonal refer to the remaining students (N=179).

Table 6: Interquartile ranges of ranks of mean grades on selected subjects, by course

School type	Interquartile range of ranks		
	Preprimary	Primary	Secondary
Primary	2½ - 6	4 - 8	-
All age	2 - 4	5 - 8	-
New/jnr. sec.	4 - 5	5 - 7	3 - 4
Private high	4 - 5½	5 - 8	3 - 5
Commercial	-	7 - 9	-
Vocational	-	3 - 4	-
Comprehensive	-	2 - 6	2 - 4
Technical	1 - 3½	1 - 5	2 - 3
Post-sec.	-	-	-
Trad. high	1 - 3	1 - 4	1 - 1
Possible range	1 - 6	1 - 9	1 - 5
No. of ranks	8	10	7

1.4 Differences between school backgrounds

It was reported in the preliminary report (5) that there was a clear difference in the entrance qualifications of students from three types of schools there labelled, general (primary, all age, new and junior secondary, private, extension and evening schools, commercial colleges, and vocational schools and institutes), intermediate (comprehensive and technical high schools and post-secondary institutions) and academic (traditional high schools). In order to find whether the same distinction could be made in respect of final grades, the following procedure was followed.

Firstly, within each course, several categories of schools were eliminated because there were fewer than 10 students from that category taking that course. This left 6 categories in the Preprimary, 9 in the Primary, and 5 in the Secondary course. Secondly, optional subjects were eliminated whenever the number of students in any of these categories fell below 10; in fact only Primary Social Studies and General Science were retained. This gave 8 subjects in the Primary, 10 in the Preprimary, and 7 in the Secondary course. Thirdly, the mean grade for each category of student in each course in each subject was calculated, and the categories ranked for each subject in each course. Finally, the interquartile range (the range for the middle half) of the ranks for each category on the subjects in each course was found. The results are shown in Table 6. (The halves occur in the first column because of the frequent need to interpolate when finding the quartiles of a set of eight numbers).

Table 6 shows quite clearly that, in all courses, students from primary and all age schools, new or junior secondary schools, private high schools, commercial colleges and similar institutions tended to obtain very similar ranges of grades, and that these grades tended to be lower than students from other school backgrounds. Students from the traditional high schools tended to obtain the highest grades, although there does seem to have been considerable overlap with students from the technical high schools, especially in the Preprimary and Primary courses; however, students from high schools obtained higher mean grades than students from technical high schools in 11 of the 18 subjects ranked in these two courses, including in both cases the average examination grade and the internship grade. The results seemed to justify a continued separation of high school and technical high school students for the purposes of analysis.

Table 7: Ranking of examination grades for students from various educational backgrounds

Criterion variable	Course		
	Preprimary	Primary	Secondary
English Language	3 2 1[a]	3 1 2	3 2 1
Mathematics	3 2 1	3 2 1	2 3 1
Education I	1 2 3	3 1 2	3 2 1
Education II	3 1 2	3 2 1	2 3 1
Examination average	3 2 1	3 2 1	3 2 1
Practice teaching	3 1 2	3 1 2	3 2 1
Individual study	3 2 1	3 1 2	1 2 3
Internship	2 3 1	3 2 1	2 3 1
Social studies	-	2 3 1	3 2 1
General science	-	3 2 1	2 1 3
Art & Craft	-	3 1 2	-
Music	-	3 2 1	-
English Literature	-	-	3 1 2
Comprehensive education	-	3 2 1	3 2 1

[a]The three numbers are the ranks for students from General, Intermediate and Academic education backgrounds, respectively (1=highest).

Table 6 confirms that it is reasonable to combine students from comprehensive and technical high schools. It also indicates that students from the vocational schools and institutes should also be included in this intermediate group, which seems reasonable since they have been selected by examination from students in the other categories of school offering a general education.

There were only 12 students who had transferred from other post-secondary institutions, 4 in the Pre-primary, 3 in the Primary and 5 in the Secondary course. The mean grades of these students were generally high, ranking 1st or 2nd in 17 out of the 25 subjects considered. It was decided to combine these students with students from high schools.

The grouping of school backgrounds suggested in the preliminary report was therefore revised to the following:

General Education

Primary schools
All-age schools
New & junior secondary schools
Private, extension and evening schools
Commercial colleges

Intermediate Education

Technical high schools
Comprehensive high schools
Vocational schools and institutes

Academic Education

Traditional high schools
Post-secondary institutions

Table 7 shows how students from these groups performed in relation to each other. Students from an academic education background ranked first in 22 out of 33 cases, and students from a general education background ranked third in 25 cases.

Two new dichotomous predictor variables were created to reflect the above classification; one distinguished General Education students from others and the second distinguished Academic Education students from others.

1.5 Analyses carried out in this study

The data analysis sought to examine the relation between the predictor variables and the criterion variables using multiple linear regression. A total of 41 predictor variables were considered initially, as follows:

Biographical variables

Age, Sex, Place of residence (Kingston/other).

Experience variables

General education background, Academic education background, Teaching experience, Previous teacher education, Other work experience.

General Qualification variables

No. of JSC passes, No. of JSC sittings, Reciprocal of the no. of JSC sittings, No. of JSC passes per sitting, No. of GCE passes, No. of subject passes at JSC or GCE, Entrance examination scores (Mathematics, English Language, and Learning Potential).

Subject qualification variables

Passes at JSC or GCE in English Language, Mathematics, Civics, Biology, General Science, Health Science, Bible Knowledge, English Literature, Geography, History, Any Home Economics subject, Any science subject, Any social studies subject; GCE passes in English Language, Mathematics, Biology, Health Science, Bible Knowledge, English Literature, Geography, History, Any Home Economics subject, Any science subject, Any social studies subject.

Statistics on most of these variables are presented in the interim report (5). Several subject qualifications on which data were initially collected (Any commercial subject, Any foreign language, Agriculture, Art and/or Craft, Any technical/industrial subject, Physics, Chemistry, Economics and Sociology) were not included here because less than 10% of students in any course had passes in these subjects. The two variables General education background and Academic education background were created as indicated in the last section.

The list of criterion variables is given in Table 2. The regression analysis proceeded like a detective attemping to make sense of an extremely complex situation by gradually eliminating possibilities and constantly rearranging and checking the remaining data until a consistent pattern emerge. The following steps were undertaken:

1. Correlations of all predictors with all criterion variables were calculated, and good and poor predictors identified.

2. Multiple linear regressions of all criteria on all the predictors were calculated, and infrequent predictors eliminated from further consideration.

3. The set of predictors was further reduced by elimating some which showed high correlations with other predictors, and the regression analysis repeated.

4. The remaining predictors were checked for nonlinear relations with the criteria, and for interactions in the prediction of the criteria. The reduced list of predictors was also checked for multicollinearity by regressing each predictor on the other predictors.

5. The regression analysis was repeated using the nine best predictors as revealed in Step 3 and checked in Step 4.

6. The regression analysis of examination grades was repeated using the five best predictors from Step 5, and the feasibility of combining data from preprimary and primary students was examined.

7. The results of Step 6 were checked for reliability and the possibility of combining results from all three courses.

8. The consequences of colleges using a cut-off score on the LP entrance examination were examined.

These steps and the results obtained are described in the respective sections of Chapter 2.

Table 8: Principal correlations ($|r| \geq 0.20$) of predictors with Examination average and Internship grades*

Predictor	Exam. average			Internship		
	Prep	Prim	Sec	Prep	Prim	Sec
Age		-21				
General education		24				
Academic education			23			
Teaching experience						22
Previous teacher ed.						26
No. of JSC sittings			-24			
Reciprocal no. of JSC sittings			27			
No. of JSC passes/sitting	24		34			
No. of GCE passes	21	29	41			
No. of subject passes			22			
Maths. entrance score		40	24			
English entrance score	32	31	41			
LP entrance score		21				24
Eng. Lang. pass	29					
Gen. Sci. pass	20					
Eng. Lit. pass			21			-26
GCE Eng. Lang.		22	34			
GCE Biology			26			
GCE BK			26			
GCE Eng. Lit.		23	21			-26
GCE History		20				-23
GCE Home Ec.				21		
GCE Science			21			
GCE Social Studies		28	21			-21

*Decimal points omitted.

CHAPTER 2 : RESULTS

2.1 Correlations between predictor and criterion variables

Of the 1353 correlations calculated between the predictors and the criteria, 172 were 0.20 or more in absolute value (positive or negative), more than a half of these relating to the Secondary course. As an illustration, Table 8 gives the predictors which showed correlations of this size with the two principal criteria, the Examination average and the Internship grade. Only two predictors, Number of GCE passes and the English entrance examination score, were related to the Examination average in all courses; Number of JSC passes per sitting, the Mathematics entrance score, and GCE passes in English Language, English Literature and any Social Studies subject gave correlations over 0.20 in two courses. There were only scattered correlations over 0.20 with the Internship grade, and none at all in the Primary course. In the Secondary course, possession of a GCE pass in English Literature, History or any Social Studies subject was associated with a lower Internship grade.

Taking all criteria together, the best predictors were No. of GCE passes, with 13 correlations of 0.20 or more, Mathematics entrance score (12), English entrance score (10), GCE English Language (9) and Academic education (9), closely followed by English Literature pass, GCE English Literature, GCE History, and any GCE Social Studies subject. The weakest predictors were Previous work experience and BE pass, which gave no correlations of 0.20 or more, and Sex, Previous teacher education, No. of JSC passes, Biology pass, Health Science pass, History pass, Any social studies pass, GCE Mathematics, GCE Health Science, GCE Geography, all of which gave only one such correlation.

It was dangerous to eliminate predictors at this stage, because a predictor which has a small correlation with a criterion variable can, if it is only weakly related to other predictor variables, substantially improve the accuracy of prediction in a multiple linear regression. Therefore, all variables were carried forward to the next stage.

Table 9: Order of entry of best predictors of Examination average and Internship grades (initial regression analysis)

Predictor	Exam. average			Internship		
	Prep	Prim	Sec	Prep	Prim	Sec
Age		4*				
Residence	2					
Teaching experience						4
Previous teacher ed.						1
No. of JSC passes/sitting			3			
No. of GCE passes	3	3	1			6
Maths. entrance score		1	2			
English entrance score	1	2				5*
LP entrance score			4			3
Maths. pass						7*
Eng. Lit. pass						2*
Science pass	4					
GCE Biology				2		
GCE Health Science						8
GCE Eng. Lit.					1	
GCE Geography				3		
GCE Home Economics				1		
Multiple R	0.48	0.53	0.55	0.33	0.13	0.55

*Regression coefficient negative.

2.2 Initial multiple linear regression analysis

The initial regression analysis was restricted to students with at lease one JSC pass, since the variables Reciprocal no. of JSC sittings and No. of JSC passes per sitting were not defined for students with no JSC passes. This was not a serious restriction, since only 6%, 2% and 12% of the students in the Preprimary, Primary and Secondary courses, respectively, were so eliminated.

Each of the 33 criterion variables was regressed on all 41 predictor variables using a stepwise procedure which was halted as soon as the increment in the R^2 fell below 0.02. Table 9 illustrates the results for the Examination average and Internship grade. Overall, there was little consistency between one subject and another, or from one course to another in the same subject. This was, of course, partly a result of the unevenness in the correlations between predictors and criteria, but largely an artifact of the stepwise linear regression procedure which is rather sensitive to small changes in predictor-criterion correlations.

The predictors most frequently entering the regression equations were the English entrance examination score (15 equations), No. of GCE passes (10), Place of residence (8 : in most cases, Kingston residents tended to score lower than others), Mathematics entrance examination score (7), Age (5: older students tended to score lower than younger students), and LP entrance examination score (4). Multiple correlations were noticeably higher in predicting examination grades (the median R was 0.49 with interquartile range 0.37 to 0.57) than in predicting teaching grades (median 0.31, interquartile range 0.13 to 0.33).

2.3 Second Multiple linear regression analysis

As already noted, the results of the first multiple linear regression analysis showed a great variation from one subject to another and from one course to another. One reason for this was the inclusion in the predictor set of several closely related variables, any one of which could replace any of the others without making a great difference to the accuracy of the prediction. There was also the possibility that the computer program may inevitably give inaccurate results in this situation (known as multicollinearity). Upon examination, dangerously high correlations were found between English Literature pass (JSC or GCE) and GCE English Literature (0.97 overall), between GCE History and any GCE Social Studies subject (0.95), between No. of JSC passes and No. of subject passes at JSC or GCE (0.90), and between No. of JSC sittings and Reciprocal no. of JSC sittings (-0.89). There were

Table 10: Predictors included in second multiple linear regression analysis.

Predictor	Preprimary	Primary	Secondary
Age	✓	✓	✓
Sex		✓	✓
Residence	✓	✓	✓
Academic education background	✓	✓	✓
Teaching experience	✓	✓	✓
Work experience	✓	✓	✓
No. of JSC passes	✓	✓	✓
No. of JSC sittings	✓	✓	✓
No. of JSC passes per sitting	✓	✓	✓
No. of GCE passes	✓	✓	✓
Mathematics entrance score	✓	✓	✓
English entrance score	✓	✓	✓
Learning Potential	✓	✓	✓
Passes at JSC or GCE in:			
Maths.	✓	✓	✓
Civics	✓	✓	✓
Home Economics	✓	✓	✓
Any Science subject	✓	✓	✓
Any Soc. Stud. subject	✓		
GCE passes in:			
Maths.			✓
English Language			✓
English Literature	✓		
Any Science subject			✓
Any Soc. Stud. subject	✓	✓	✓
No. of variables	19	18	21

several other pairs of variables whose intercorrelations within each course exceeded 0.70. It was therefore decided to eliminate predictor variables until no correlation over 0.70 remained. Single subject variables were eliminated in preference to more general variables, and in other cases preference was given to the predictor with higher correlations with the principal criteria.

A second reason for variation in regression equations was the chance entry of unlikely variables late in the stepwise procedure. To reduce this possibility, it was also decided to eliminate all predictors whose correlations with the criterion variables were all less than 0.10 and which appeared in the first regression analysis only once or not at all. At the same time, remaining single subject variables where the pass rate within any course was less than 10% or greater than 90% were eliminated, since they could not be expected to discriminate satisfactorily.

A third reason for variation in regression equations could have been the relatively small numbers of students with data on all 41 predictors. The reduction in the number of variables automatically increased the number of students included in each analysis.

The list of predictors retained for the second regression analysis is given in Table 10. It will be seen that the number of predictor variables had been reduced to about half the number used in the first analysis. Sixteen of the predictors were common to all courses.

The number of students included in the analyses of the compulsory subjects were 130,452 and 122 respectively. These numbers were considered adequate. Numbers were also considered adequate for the analyses of all optional subjects in the Primary course (all numbers exceeded 100), but only for Comprehensive Education (N=84) in the Secondary course. A total of 29 multiple linear regression equations were computed, the stepwise procedure again being terminated when the increment in R^2 fell below 0.02.

Table 11 summarises the regression results for the two principal criteria. They are not greatly different from those in Table 8. That chance factors are still operative is shown by the continued inclusion of predictors with negative regression coefficients late in the stepwise procedure (suggesting anomolously that, all other things being equal, students with lower scores on certain qualification variables should be preferred to those with higher scores).

Table 11: Order of entry of best predictors of Examination average and Internship grades (second regression analysis)

Predictor	Exam. average			Internship		
	Prep	Prim	Sec	Prep	Prim	Sec
Age		4*				
Residence	2					
Teaching experience						3
No. of JSC passes per sitting			3			
No. of GCE passes	3	3	1			5
Maths. entrance score		1	6			
English entrance score	1	2	2			4*
LP entrance score			4			2
Maths. pass						6*
GCE Maths.			5*			
GCE Eng. Lit.					1	1
GCE Science subject					2	
GCE Soc. Stud. subject				1		
Multiple R	0.45	0.53	0.59	0.19	0.18	0.47

*Regression coefficient negative.

Multiple correlations were very similar to those obtained in the initial analysis. For predicting examination grades, the median R was 0.46 with interquartile range 0.33 to 0.53, and for predictingteaching grades the median R was 0.26 with interquartile range 0.18 to 0.32. The predictors frequently entering the regression equations were the English entrance examination score (16 equations), No. of GCE passes (9), the Mathematics entrance examination score (8), GCE English Literature pass (6), Place of residence (6), Age (5) and Learning Potential (5). Academic educational background did not enter any equation, and Sex, Previous work experience, No. of JSC sittings, JSC or GCE passes in Civics, any science subject and any social studies subject, and any GCE science subject entered only 1 equation.

There was no evidence that the individual subject passes at JSC or GCE were more effective than more general predictors in predicting achievement in the corresponding subjects in college examinations. Neither science nor social studies predictors appeared in the regression equations for Science or Social studies examination grades in the Primary course, and the corresponding result occurred in further tentative analyses carried out in other subjects with small numbers of students or unstandardised examinations. GCE English Literature seemed to enter as a proxy for No. of GCEs, with which it was moderately correlated (0.67, 0.46 and 0.45 in the three courses); in only 2 of the 6 equations where GCE English Literature entered did No. of GCE passes also enter, and in both cases the regression coefficient for GCE English Literature was negative. A JSC or GCE pass in Mathematics entered 4 equations, but in 3 cases with a negative regression coefficient. It was decided that the pattern of relationships would be clarified, and little predictive power lost, if all single subject predictors were eliminated from subsequent analyses.

Eliminating also those predictors which only entered into one equation at most, the following 9 predictors were retained for all courses:

Age
Place of residence
Teaching experience
No. of JSC passes
No. of JSC passes per sitting
No. of GCE passes
Mathematics entrance score
English entrance score
Learning Potential entrance score

Table 12: Rank order of mean Examination average and Internship grades, by groupings of selected variables

Predictor variable	Course	Exam. average Group mean ranks[a]	Internship group Group mean ranks
Age	Prep	1 2 | 4 3 5	3 1 4 5 2
	Prim	2 1 | 3 4 5	4 3 2 1 5
	Sec	2 1 | 3 5 4	5 3 4 1 2
Teaching experience	Prep	2 3 4 5 1	5 | 4 1 3 2
	Prim	4 1 2 3 5	5 | 2 3 1 4
	Sec	3 1 4 2 5	5 | 4 3 2 1
No. of JSC passes	Prep	1 | 6 4 2 3 5	6 5 2 1 3 4
	Prim	1 | 6 3 4 5 2	1 5 6 4 3 2
	Sec	1 | 4 5 6 2 3	6 4 2 5 3 1
No. of JSC passes per sitting	Prep	5 4 3 | 2 1	4 3 1 5 2
	Prim	5 4 3 | 1 2	4 5 2 1 3
	Sec	5 3 4 | 2 1	2 3 5 4 1
No. of GCE passes	Prep	4 5 | 3 2 | 1	5 1 3 2 4
	Prim	5 4 | 2 3 | 1	4 3 2 5 1
	Sec	5 4 | 3 2 | 1	5 1 2 4 3
Maths. entrance score	Prep	3 4 5 | 1 2	3 4 5 1 2
	Prim	5 4 3 | 2 1	5 4 3 2 1
	Sec	5 4 3 | 2 1	5 2 4 1 3
English entrance score	Prep	6 7 5 | 2 4 3 | 1	6 7 4 2 5 3 1
	Prim	7 6 5 | 4 3 2 | 1	4 6 7 3 2 5 1
	Sec	7 6 5 | 4 3 2 | 1	1 4 3 2 5 7 6
Learning Potential	Prep	5 | 3 4 2 | 1	1 4 5 3 2
	Prim	5 | 3 4 2 | 1	5 2 3 1 4
	Sec	5 | 2 3 4 | 1	5 1 4 2 3

[a] The numbers give the ranks of the mean scores on each criterion variable (1=highest) of students in the groups defined by each predictor variable (starting with the lowest group). For example, students in the lowest age group in the Pre-primary course had the highest exam average. Vertical broken lines indicate consistent cut-off points.

Before preceding with a third regression analysis, the retained predictors were examined to see if the relation of any of them to the criterion variables was in fact non-linear or non-additive, and if there was still multicollinearity lurking among the retained predictors.

2.4 Nonlinearity, interaction and multicollinearity checks

Nonlinearity

The multiple linear regression technique assumes that all predictors are linearly related to all criteria. If the relation is non-linear, and especially if it U-shaped (for example, if students with no or many years of teaching experience receive lower internship grades than those with a few years' experience), then the actual strength of a relationship can be seriously underestimated. This type of linearity was therefore investigated as a possible reason for the low multiple R's so far obtained.

The relation of the retained predictors (except Place of Residence, which is dichotomous) to the compulsory subjects in each course was examined as follows. Firstly, the range of values of the predictor variables was divided into a number of intervals (between 5 and 7) containing approximately equal numbers of students. The mean scores of the students in each interval were then calculated and the mean scores ranked. Non-linearity of the type mentioned above would be indicated if the middle groups consistently ranked higher or lower than the extreme groups. Table 12 illustrates the results in the cases of the two principal criteria.

For the examination average and most other examination grades, the relations to No. of JSC passes per sitting, No.of GCE passes, and the three entrance examinations scores were clear and consistent : higher qualifications went with higher performance. Younger students also tended to perform consistently higher than older students. The clearest cut off points were between ages 20 and 21, at 3 JSC passes per sitting, between 1 and 2 and again between 3 and 4 GCE passes, at a score of 50 on the Mathematics entrance examination, at scores of 65 and 80 on the Learning Potential paper. However, the difference in mean grades between students in the highest and lowest groups was rarely as much as one grade point. Teaching experience showed no consistent linear or non-linear relation to examination grades.

Table 13: Ranked mean scores on Examination average and Internship grades, by age and teaching experience (primary course students)

Teaching exp. (yr)	Exam. average					Internship				
	Age (yr)					Age (yr)				
	<20	20	21	22-3	24+	<20	20	21	22-3	24+
0	10	9	15	6	16	11=	17	19	10	14
1	1	3	17	11=	21	4	5	20	9	21
2		5	8	13	19		8	16	15	13
3		4	2	14	20		1	2	11=	7
4+			11=	7	18			16	3	18

Table 14: Ranked mean scores on Examination average and Internship grades, by Number of GCE passes and Number of JSC passes (primary course students)

No. of JSC passes	Exam average					Internship				
	No. of GCE passes					No. of GCE passes				
	0	1	2	3	4+	0	1	2	3	4+
1 - 5	24	20	11	13	6	13	20	15=	19	6
6	22	19	16	5	3	18	21	22=	24	25
7	21	23	4	17	8=	17	14	8	5	2
8	25	12	14	8=	1	15=	9	12	22=	1
9+	18	15	7	10	2	10=	7	4	10=	3

No. of JSC passes showed an interesting relation : students with no JSC passes generally achieved the highest examination grades, those with 1-5 passes had the lowest mean grade, and those with 6 or more passes were intermediate. (Further analysis showed that 83% of the 69 students with no JSC passes were from high schools and that the same percentage had obtained 3 or more GCE passes). However, this instance of non-linearity could not have led to lowered correlations, because students with no JSC passes had been excluded from previous analyses (because they had no value for No. of JSC passes per sitting).

There was little consistency in the relations between the selected predictors and the Internship and other teaching grades. Higher Mathematics entrance scores were consistently associated with higher teaching grades in the Primary and Preprimary courses, and larger teaching experience with higher teaching grades in the Secondary course, but these could have been coincidences. No evidence of a consistent non-linear pattern was found.

Interactions

A further possible cause of low correlations between the predictor and criterion variables is interaction among the predictor variables. For example, it might be that younger students with a little teaching experience obtain higher internship grades than older students or than young students with no teaching experience; this would constitute an interaction between Age and Teaching experience in predicting internship grades.

The number of possible interactions between 41 predictors is very large; only two were investigated: Age with Teaching experience and Number of GCE passes with Number of JSC passes. Firstly, the values of each variable were divided into 5-7 groups (as for the linearity analysis); the students with each combination of scores on the two predictors were then identified, and their mean examination average and internship grade calculated; and finally the means for combinations containing 10 or more students were ranked and the table examined for interaction patterns. Tables 13 & 14 show the results for the primary course students.

Table 13 shows a tendency for students in the lowest two age groups, and students in the next two age groups with maximum teaching experience, to have a higher Examination average than other students; there is a weaker indication

Table 15: Order of entry of best predictors of Examination average and Internship grades (third regression analysis)

Predictor	Exam average			Internship		
	Prep	Prim	Sec	Prep	Prim	Sec
Age (negative)		4				
Residence	-					
Teaching experience						1
No. of JSC passes						
No. of JSC passes per sitting			3			
No. of GCE passes	3	3	1			4
Maths. entrance score	4	1			1	
English entrance score	1	2	2	1		3*
LP entrance score			4			2
Multiple R	0.47	0.55	0.55	0.15	0.09	0.41

*Regression coefficient negative.

of a similar trend as regards the Internship grade. The broken line in each table suggested a dichotomy between higher - and lower-ranking students. To investigate these dichotomies further, several artificial variables were created distinguishing the two sets of students, and the correlations of these variables with grades on the compulsory subjects in each course were calculated. In many cases, the correlations of the artificial variables with the criterion variables were higher than the correlations of age or teaching experience with the criterion variables; but/no artificial variable was the improvement consistent across subjects or courses. It was concluded that no general improvement in prediction could be obtained by including the interaction between age and teaching experience among the predictors.

Similarly, weak interactions between Number of GCE passes and Number of JSC passes were discernible (see Table 14), but all of several dichotomous variables created to reflect these interactions showed correlations with the criterion variables which were generally lower than the correlations shown by Number of GCE passes. This interaction was therefore also excluded from further consideration.

Multicollinearity

On page 19 , we pointed out the undesirable effects of high correlations among the predictor variables. Lewis-Beck (4:58) has drawn attention to the fact that similar difficulties arise whenever the multiple correlation between any one predictor variable and the other predictors is high. To check on this possibility, these multiple correlations were calculated for the set of 9 predictors listed on page 23 .

The median multiple correlations were 0.57 in the Preprimary course, 0.37 in the Primary course and 0.47 in the Secondary course. Consistently high multiple correlations occurred in the cases of Age (0.63, 0.43 and 0.63 respectively) and Teaching Experience (0.68, 0.45 and 0.64 respectively, the two variables with the highest first-order intercorrelations among the 9 predictors (0.57, 0.36 and 0.61 respectively). It was concluded that some difficulties might occur in the

Table 16: Results of fourth multiple regression analysis

Criterion variable	N	R^a	Regression coefficients[b] Age	NGCE	Maths.	Eng.	LP
Preprimary course							
English Language	138	47	-052			054	
Mathematics	138	63			060		
Education I	138	38			-012	013	-050
Education II	138	19				011	-031
Exam average	138	30		055		018	
Primary course							
English Language	604	50		160		058	047
Mathematics	604	57			070		
Education I	475	28			021	024	
Education II	475	28	-029	154		013	
Comprehensive Education	113	38		346	019	042	
Social Studies	393	15			009		
Gen. Science	396	33		276	014		
Art & Craft	120	20				056	
Music	155	40		643	015		
Exam. average	604	57	-035	222	022	022	
Secondary course							
English Language	239	52		144	009	048	
Mathematics	36	55		226	056	-021	
Education I	134	57	-114	140	018	035	
Education II	134	49	-149	128		023	
Comprehensive Education	99	30		134		013	013
Social Studies	41	67	-115	370	016		
Gen. Science	52	42		160	031	-056	
English Lit.	63	35		316			026
Exam. average	239	50		244	010	014	

[a] Multiple correlation for all five predictors. Decimal points omitted.

[b] First coefficient underlined. Coefficients for $R^2_{change} < 0.01$ omitted. Decimal points omitted.

interpretation of the multiple regression results for the Preprimary and Secondary courses unless Age or teaching Experience were eliminated, but that multicollinearity should not cause difficulties for the Primary course results.

2.5 Third multiple regression analysis

For the third multiple regression analysis, equations were calculated relating 29 of the criteria in Table 2 to the 9 selected predictors listed on page 23. (The numbers of students with full data were still too small in four of the optional subjects in the secondary course) In this case, the stepwise procedure was terminated when the increment in R^2 fell below 0.01.

The results were very similar to those obtained in previous analyses. For predicting examination grades, the median R was still 0.46 with interquartile range 0.32 to 0.54; for predicting teaching grades, the median R fell slightly to 0.22 with interquartile range 0.16 to 0.30. Table 15 summarises the results for the two principal criteria; comparison with Tables 9 and 11 shows that there has been no loss in the predictability of the Examination average grade by the reduction from 41 to 9 predictors, but that the predictability of Internship grades has suffered considerably. The detailed results for all 29 criteria show that, in fact, only Internship lost predictability in all courses; apart from Education II (Preprimary & Secondary), Practice teaching (Secondary) and Individual study (Secondary), multiple Rs showed only minor fluctuations from one analysis to another.

These results suggests that (1) the procedure so far has uncovered the critical predictors of examination performance in teachers' college, and that (2) Internship may (except possibly in the Secondary course) be unpredictable from the data collected before selection, multiple correlations being seriously influenced by chance factors. Consequently, no further analysis of teaching grades was performed.

2.6 Fourth multiple regression analysis: Examination grades

The results of the third regression analysis suggested that the set of critical predictors of examination results might be further reduced. Outstanding predictors were English entrance score, which appeared in 19 of the 29

equations, No. of GCE passes (15), Mathematics entrance score (13) and Place of residence (11). The least useful predictors were No. of JSC passes per sitting, which only appeared in 3 equations, Teaching experience (5), No. of JSC passes (6) and LP entrance score (6). It was therefore decided to perform a further analysis with the following 5 criteria:

Age
No. of GCE passes
Mathematics entrance score
English entrance score
Learning Potential entrance Score

Place of residence was omitted because it was doubtful whether selection committees would be willing to give preference to candidates on that basis. The Learning Potential entrance score was included because it is highly regarded and would certainly be used in selection procedures; its failure to appear more often in the regression equations so far obtained is discussed below (Section 2.8).

The results of the fourth regression analysis are given in Table 16. In order to make sense of these results we shall look at the predictability of each criterion in turn.

The Examination average grade was well predicted in the primary and secondary courses, the multiple correlations of 0.57 and 0.50 being of the same order as the highest values commonly reported in prediction studies.

The multiple correlations had remained remarkably stable over the various analyses, which boosts one's confidence in the validity of the results. Furthermore, the regression coefficients were fairly similar in the two courses (bearing in mind their notorious sensitivity to small changes in the first-order correlations). By contrast the prediction was rather poor in the preprimary course, the R having fallen considerably from an acceptable value of 0.47 in the third analysis.

English Language and Mathematics examination grades were well predicted in all courses, but in no case was the multiple correlation more than 0.05 greater than the first-order correlation with the respective entrance examination. The increment would have therefore been specially susceptible to chance variations, so it is not surprising to find that the regression coefficients for the additional predictors

show little consistency between the two courses. Prediction of performance in these two subjects is probably best based solely on the corresponding entrance examination score.

The validity of prediction of performance in Education I and II and in Comprehensive Education varied widely, from a high R of 0.57 for Secondary Education I to a low R of 0.19 for Preprimary Education II. However, most of the Rs had remained fairly stable over the several analyses, the only big drops occurring in the case of Preprimary Education II and Primary Comprehensive Education. The Preprimary data was exceptional in showing negative correlations between the two Education grades and both the Mathematics and the LP entrance scores.

The optional subjects also led to widely varying multiple correlations, with only two out of ten exceeding 0.40. The small numbers make the secondary course results extremely tentative, but even the larger numbers in the primary course do not seem to have led to very encouraging results: the multiple correlations are low and there is little consistency with the secondary results.

The preprimary course results were examined more closely in order to explain the anomolous findings with respect to Education I and II. The drop in Education I predictability from the third to the fourth analysis seemed to have been largely due to the omission of Place of residence, which actually entered into 4 out of the 5 regression equations for examination grades in this course. The preprimary course was only offered at 4 of the 7 colleges (not counting one college with only 2 students), and only at St. Joseph's (26%) and Shortwood (30%) was there a significant percentage of students from Kingston. In both these colleges, rural students obtained higher mean grades on both Education papers. This might explain the drop in R, but not the low resulting value of R.

The correlations of Education I with the Mathematics entrance scores was -0.29 amongst the total preprimary group, but varied from -0.30 to +0.49 within colleges. Similarly, the overall correlation with the LP entrance score was -0.30, but varied from -0.04 to 0.19 within colleges. Correlations of Education II with the entrance scores showed a similar variation from college to college. It was concluded that the anomolous negative correlations were artifacts (possibly arising from inter-college variations in performance levels and selection policies) and did not indicate negative correlations in the population from which college students are drawn.

Table 17: Regression coefficients for prediction of examination grades from five best predictors (preprimary and primary students)

Criterion variable	N	R^a	Regression coefficients[b]				
			Age	NGCE	Maths.	Eng.	LP
English Language	749	49		126		057	039
Mathematics	749	59			071		
Education I	637	20				021	
Education II	637	23		106		012	
Exam. average	749	53	-029	180	019	023	

[a] Multiple correlation for all five predictors. Decimal points omitted.

[b] First coefficient underlined. Coefficients for $R^2_{change} < 0.01$ omitted. Decimal points omitted.

Table 18: Regression coefficients and their standard errors for prediction of examination grades from five best predictors

Predictor	Preprimary and Primary (N=749)		Secondary (N=239)	
	Coefficient	SE	Coefficient	SE
Age	-0.02954	0.01230	-0.02982	0.04277
No. of GCE passes	0.17950*	0.04259	0.24276*	0.02737
Maths. ent. score	0.01915*	0.00203	0.01130	0.00580
English ent. score	0.02333*	0.00347	0.01602*	0.00354
LP entrance score	0.00668	0.00356	0.00661	0.01300
Constant	3.07413	-	3.77182	-

*Significant at the 0.05 level (1-tailed test).

In order to check this conclusion, it was decided to repeat the analyses after pooling the preprimary with the primary students. There are two good a priori reasons for doing this in any case. Firstly, preprimary and primary students seem to be drawn from the same population as far as entrance characteristics are concerned (see (5)), and in some colleges the decision as to which of the two courses a student is to follow is not made on entry but is delayed until the second year. Secondly, the preprimary and primary courses have a great deal of commonality, both in terms of course work and examination papers; in the compulsory examination subjects, the only difference occurs in Mathematics, and then only in one of the three papers.

The results are given in Table 17. They are not greatly different from the results for the Primary course students alone (Table 16), although there is a further noticable drop in the predictability of Education grades. It was decided to combine data for Preprimary and Primary course students for the remainder of the analysis.

2.7 Final multiple regression analyses: Examination average

Up to this point, predictors have been retained on the basis of the frequency with which they entered early into the regression equations, using rather arbitrary cut-off points. The time has come to look more carefully at the results to date, in order to reduce the prediction equations to the simplest possible form without losing predictive power. We shall deal only with the prediction of the average examination grade, probably the single most important criterion.

The results reported in Tables 16 and 17 suggest that the average examination grade can be reasonably well predicted using only the student's number of GCE passes and scores on the Mathematics and English entrance examinations. However, we have so far nothing to tell us whether it is necessary to use all these three predictors, or indeed whether we can do better by also including age and the LP score. The usual approach to this problem is to find the statistical significance of each regression coefficient, and then to omit variables whose coefficients are not significant (say at the 0.05 level). However, the usual tests (including those reported on the output from standard computer programs) assume that the sample is chosen at random from subjects with a fixed set of values for the independent variables, and this assumption cannot be made here: it is difficult to consider each cohort of teachers' college students as a random sample from any population, and the values of the independent variables change from one cohort to the next. It is for this reason that we have scrupulously avoided any mention of significance up to this point.

Mosteller & Tukey (6) have recently suggested a way out of this difficulty. Their method is an application of the jackknife procedure. The subjects are first divided into ten equivalent groups; ten regression equations are then recomputed on the data sets obtained by leaving out each of the ten groups in turn. From these equations, ten new equations (called pseudo-regression equations) are computed by a simple procedure in which each regression coefficient for a reduced data set is compared to the corresponding coefficient for the full data set. Mosteller & Tukey (6:135) state that the pseudo-regression equations behave as if they were derived from ten independent samples from the same population as the given data set. The standard error, and hence Student's t and a determination of significance, can then be calculated for each regression coefficient from the standard deviation of the corresponding ten pseudo-coefficients.

The jackknife procedure was applied to the prediction of the average examination grade from the five predictors used in the fourth multiple linear analysis, firstly for students in the preprimary and primary courses and secondly for students in the secondary course. The ten groups used in each case were defined by systematic random sampling using the last digit of each student's registration number. The results are given in Table 18. It was concluded that performance in the Preprimary and Primary courses could best be predicted by combining data on a student's No. of GCE passes and Mathematics and English entrance scores, but that for the Secondary course No. of GCE passes and the English entrance score were adequate.

For practical purposes, it would be convenient if the same combination of entrance characteristics could be used to select students for all courses. We have already seen that is reasonable to combine the Preprimary and Primary course students; the regression coefficient for these students are not so very different from the coefficients for the Secondary course students. Since multiple correlation coefficients are known to be insensitive to small changes in the regression coefficients, it is possible that a single combination of predictors could be found to serve both groups of students. Six combinations were tried:

(i) Using No. of GCE passes and Mathematics and English entrance scores as predictors, with coefficients weighted by sample size.

(ii) As (i), with the coefficients weighted by standard error.

(iii) As (i), with coefficients rounded off for easier calculation.

(iv) As (iii), with one or both of the non-significant predictors Age and LP entrance score also included.

In all cases, the correlation of the combination with the average examination grade amongst the preprimary and primary students exceeded 0.511, not much less than the multiple regression coefficient of 0.526. Among the secondary students, four of the six correlations exceeded 0.478 compared to the multiple regression coefficient of 0.497. It was concluded that the same combination of predictors could be used to predict performance among both groups of students, with very little loss of predictive power.

The best combination with weighted coefficients was:

0.21801 x No. of GCE passes
+0.01725 x Maths. entrance score
+0.021526 x English entrance score

which gave correlations of 0.512 and 0.486 respectively. The best combination with rounded coefficients was:

0.20 x No. of GCE passes
+0.02 x Maths. entrance score
+0.02 x English entrance score
-0.02 x Age

which gave correlations of 0.527 and 0.780 respectively. The latter combination is preferable for ease of operation and gives predictions which are only slightly less than optimal.

2.8 The problem of the LP entrance score

It may be noted that the LP entrance score does not occur among the significant predictors (Table 18) or those selected for practical purposes in the last section. This would appear to contradict the common wisdom that has led most teachers' colleges to admit only students scoring above a certain LP score (varying from 60 to 70) and to ignore the other entrance scores; but in fact it is an artifactual consequence of this policy, because the present sample has students with the entire range of scores on almost all predictors except the LP score. The effect of the restricted range of LP scores is to reduce the size of the calculated correlations so that they grossly under-estimate the correlations that would have been found if students from the entire range of LP scores had been allowed to enter college - and, since students are selected from applicants with the entire range of scores on all predictors, it is this latter correlation which is needed for the multiple regression analysis.

Since there has been no recent year when reliable LP scores were available but not used in student selection, this problem would seem to be intractable. Fortunately, Guilford (2:341) has given a formula for estimating the correlations that would have been obtained had there been no restriction on the range. This formula requires knowledge of the standard deviation of the LP score in the group of applicants from which our sample was selected, but this was not available. However, Professor L.H.E. Reid, the author of

Table 19: Regression coefficients for prediction of average examination grades from five best predictors, with and without correction for restriction of range on Learning Potential[a]

Predictor	Preprimary and Primary (N=749)		Secondary (N=239)	
	Uncorr.	Corrected	Uncorr.	Corrected
Age	-029			
No. of GCE passes	180	199	244	294
Maths. ent. score	019		010	
Eng. ent. score	023		014	
LP entrance score		021		022
Multiple R	53	55	50	52

[a]First coefficient underlined. Coefficients for $R^2_{change} < 0.01$ omitted. Decimal points omitted.

the test, kindly supplied data on the following year's set of applicants; based on his report that there was very little change in the distribution of LP scores between 1975 and 1979, the standard deviation of these scores was used as an estimate for the present sample. Since we have had to use a double estimation procedure, the results should be treated as indicative rather than definitive.

Table 19 shows the corrected and uncorrected multiple regression coefficients and multiple correlations for the prediction of Examination average grade in the two groups of students. The multiple correlations have only changed slightly, but the coefficients have changed drastically: the average examination grade is efficiently predicted in both groups using only Number of GCE passes and the LP entrance scores. This does not, of course, mean that the Mathematics and English entrance scores are after all not good predictors, but it does suggest that the LP score alone contains as much predictive information as those two scores combined. If, for one reason another, no LP score were available then the Mathematics and English entrance scores could be used in its place.

The most convenience efficient predictive indices of overall performance would therefore seem to be

$$0.20 \times \text{No. of GCE passes} + 0.02 \times \text{LP entrance}$$

score for applicants to the preprimary or primary course and

$$0.30 \times \text{No. of GCE passes} + 0.02 \times \text{LP entrance score}$$

for applicants to the secondary course. Where students are assigned to courses after admission to college, the first index can probably be used with negligible loss of accuracy. It could be further simplified by multiplying both coefficients by 5 to obtain

$$\text{No. of GCE passes} + \frac{1}{10} \times \text{LP entrance score.}$$

(This does not mean that the LP score is only one-tenth as important of the number of GCE passes in predicting performance; but it does mean that, all other things being equal, one extra GCE pass has about the same significance as 10 extra points on the LP paper). Whichever index is used, one can expect the correlation between the index and average examination grade to be about 0.50.

Because of the tentative nature of the correction for restriction of range on the LP score, the procedure was not applied to any other criterion variable. In any case, it is unlikely that the correction would lead to substantial increases in their predictability, since the LP was only weakly related to individual subject grades (only 5 out of 21 exceeded 0.20) and even more weakly related to teaching grade (none were over 0.20).

CHAPTER 3 : SUMMARY AND CONCLUSIONS

3.1 Summary of method and results

This study investigated the relation of 41 predictor variables available on a student's entry into teachers' college to 33 indices of performance by the end of the three-year college programme. The data came from 1210 students, almost all of the cohort which entered the seven residential teachers' colleges in September 1976. The predictors consisted of 3 biographical variables, 5 variables measuring previous educational and work experience, and 9 general and 24 specific qualification variables based on previous examination performance. The criteria were the grades obtained in the examinations at the end of the second year (both compulsory and optional subjects, together with an average grade) and grades on Practice teaching, Individual study and Internship, analysed separately for students in the Preprimary, Primary and Secondary courses. The data were analysed in four sets of multiple linear regression analyses (in which variables which did not contribute to the predictability of the criteria were successively eliminated) and a number of reliability checks.

Several of the predictors were soon found to be only weakly related to the criteria; these included Sex, Previous teacher education, Number of JSC passes and several individual subject passes. All the individual subject passes were eliminated in the initial analyses because they added nothing to the information contained in other predictors; also eliminated early were two measures of Educational background, Previous work experience, and Number of subject passes at JSC or GCE. Variables eliminated later included Number of JSC passes per sitting and Length of teaching experience.

It was found that the Examination average grades of students in the primary and secondary courses could be efficiently predicted using their Number of GCE passes and their scores on the English and Mathematics entrance examinations. The results for the preprimary students were somewhat anomolous, probably because of their relatively small numbers, so their data were combined with that of the primary students. There was a strong suggestion that, in both resulting groups, the Examination average grade could also be efficiently predicted by an index found by adding ten times the number of GCE passes to the Learning Potential score; the correlation of this Index with students' average grades two years later was estimated to be about 0.50.

Performance on individual subjects would be much more difficult to predict. Grades on Mathematics and English examinations were well predicted by the respective entrance examination scores, with correlations in the range

0.40-0.60. Grades on the two Education papers and the various optional subjects could not be confidently predicted from any set of predictor variables; only three out of twelve multiple correlations consistently exceeded 0.40.

Teaching grades were poorly predicted by the variables included in this study. In only one case out of nine did the multiple correlation consistently exceed 0.30; this case concerned the prediction of the Internship grade in the Secondary course, where the length of teaching experience was the best single predictor and the multiple correlation coefficient was approximately 0.40.

3.2 Implications for student selection policy

The original purpose of this study was to evaluate, simplify and possibly improve the method of selection of students for teachers' colleges. The statistical analysis was intended to indicate, for example, whether the LP entrance score really was a good predictor of performance in college, whether certain subject passes at O-level might be good predictors, whether the number of sittings required for an applicant to obtain the required minimum number of JSC passes would be worth assessing, and whether the whole selection procedure might be simplified by taking account of only a little of all the data potentially available on applicants. The answers obtained to these questions are clear: overall examination performance can be fairly well predicted using only the number of GCE passes and the Learning Potential entrance score (or the number of GCE passes and the Mathematics and English entrance scores) and no other variables help very much; performance in individual subjects (except Mathematics and English) is more difficult to predict; and performance in teaching and the individual study is for all practical purposes unpredictable.

However, this study has been overtaken by events, in that a new programme was instituted in all the teachers' colleges in September 1981. The new Diploma programme is a three-course including teaching practice but no internship; entrance is restricted to students with at least 4 O-levels,* and assessment is mainly by examinations held once or in some cases twice a year instead of only at the end of the second year as before.

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*In practice, students are allowed to start the course with 3 O-levels but must pass the fourth one before starting the second year of the course. The term 'O-level' is taken to include both GCE and CXC passes.

Students with 5 JSC passes but less than 3 O-levels may be admitted to a preliminary year, but must still obtain the requisite number of GCE passes before being allowed to enter the Diploma programme. It is not immediately obvious what implications the results of the present study have for the selection of students under the new structure, since the criteria of success are different and the students enter at a different initial level.

On 16 May 1982, a committee of college principals made several recommendations concerning the selection of students for the new programme. Essentially, these provided as follows:

a. Students would be selected for the Diploma course by interview from those applicants with 4 or more O-levels.

b. Students would be selected for the preliminary year from those applicants with 5 or more JSC passes including English & Mathematics or "some number" of O-levels on the basis of the Learning Potential score and on interview. Applicants with 5 JSC passes including English but not Mathematics might be accepted for the preliminary course, but would not be eligible to enter a preprimary or primary Diploma course.

In other words, the Mathematics and Language papers would be dropped and the LP paper retained only for those with less than 4 O-levels. Let us examine these recommendations in the light of our results, assuming that our results are also valid for the criteria of the new programme. We shall ignore the interview (on which we have no data) and the teaching grades (which we have seen to be unpredictable but which in any case form a relatively small part of the new programme).

Diploma course The number of GCE passes was a consistent predictor of examination performance (see Table 8). Students with 4 or more O-levels consistently obtained higher mean Examination averages than those with 2 or less, and students with 3 passes were intermediate; except in the Primary course, where the performance of students with 2 passes was better than that of those with 3 passes, students with 0, 1 and 2 GCE passes obtained very similar Examination averages (see Table 12). The proposal to accept only entrants with 4 or more O-levels and to allow those with 3 O-levels to "trail" one O-level would therefore seem to be very reasonable.

But the question must still be asked: How big is the performance difference between those with various numbers of O-levels? Might not there be an overlap between them, so that there might be considerable numbers of students who have less than 3 or 4 O-levels who could pass the course? And if so, how could one identify those unqualified students

most likely to succeed? These are important questions at a time when the supply of applicants with 3 or more O-levels is far less than the number of places available in teacher's colleges.

Table 20 shows that the mean Examination average grades for students with 4 or more O-levels was about B-, whereas those with 2 or fewer O-levels averaged one grade less, about C+. This is not a very big difference, and is of the same order as the standard deviation of the average grade within each category of student. In other words, there were many students with 0-2 O-levels who did as well or better than many students with 4+ O-levels.

To look at the data another way, we can ask what percentage of each category of student would be likely to succeed in the teachers' college course. At the time the data was collected, the minimum passing grade in each subject was D+, but under the new programme it is C-. A student must surely obtain an overall average grade of at least C to be called successful, for an average of C- would indicate minimum passes in most subjects. Table 20 indicates the percentages of students achieving C or higher (average grade 3.5 or more), assuming that the average grade is normally distributed. Students with 4 or more O-levels are virtually certain of success, but even those with 2 or fewer O-levels have an excellent chance of success. Denial of entry to those with less than 4 O-levels might therefore result in the loss of a great number of students who could succeed in the course.

However, it must be noted that the data in Table 20 does not come from a representative sample of teachers' college applicants: they have all been selected on the basis of numbers of JSC passes and scores on the entrance examination; in particular, almost all students had LP scores of 60 or more. In other words, to avoid losing students who might otherwise succeed in the college course, the LP score should be used in addition to the number of O-level passes. This is consistent with our finding in Section 2.8 that one of the most efficient predictive indices can be formed using only these two variables. It may be noted that consideration of the LP score in addition to the number of GCE passes increases the predictive validity of selection from 0.33 in the preprimary and primary courses and 0.41 in the secondary course to 0.55 and 0.52 respectively (Table 19), a substantial improvement.

It is therefore recommended that:

1. Applicants for the Diploma course with 4 or more O-levels should not be required to take the Learning Potential entrance examination.

2. Applicants with less than 4 O-levels should take the Learning Potential entrance examination, and that those with sufficiently high values of the index "No. of O-levels + $\frac{1}{10}$ x LP score" should

Table 20: Mean Examination average grades, by course and number of GCE passes[a]

No. of GCE passes		Preprimary	Primary	Secondary
0-2	N	150	680	116
	Mean	4.56	4.82	5.05
	SD	0.77	1.02	1.06
	PS[b]	91.6	90.2	92.8
3	N	10	48	77
	Mean	5.10	5.43	5.77
	SD	0.81	1.05	1.09
	PS	97.6	96.7	98.1
4+	N	13	32	133
	Mean	5.44	5.92	6.16
	SD	0.79	1.07	1.11
	PS	99.3	98.8	99.2

[a]On a 10-point scale, from 9=A- to A+, 8=B+, ... to 1=D, 0=D+ or less.

[b]Percentage of students obtaining an average grade of 3.5 or more (C or higher), assuming a normal distribution.

be considered for entry subject to their satisfying other requirements. A suggested cut-off point would be an index of 10, equivalent to that of an applicant with 4 O-levels and an LP score of 60; this would mean that applicants with 3 O-levels and an LP score of 70 or more, and applicants with 2 O-levels and an LP score of 80 or more, could be accepted into the Diploma course and allowed to "trail" one or two O-levels. Others could only enter the preliminary year.

Preliminary year Although the main purpose of the preliminary year seems to be to allow students to gain the requisite numbers of O-levels in order to qualify for the Diploma course, the present study might have some implications for student selection procedures insofar as the old college examinations resemble the O-level examinations. Ideally, one would like to analyse separately the data from those students with less than 4 O-levels, especially the 50% of the 1976 cohort who had no O-level passes, in order to find a substitute for the "No. of GCE passes" which proved so predictive in the entire group; but to do so would have prolonged an already long-drawn-out study. The best we can do is to take guidance from the results for the preprimary and primary courses, where, as Table 20 shows, very few students had more than 2 O-levels. For these students, the LP score had a correlation (corrected for restricted range) of 0.48 with the Examination average grade, which is only slightly smaller than the multiple correlation of 0.53 obtained by including No. of GCE passes in the prediction equation, and is approximately the same as the multiple correlation of 0.47 obtained by predicting the Examination average from the Mathematics and English entrance scores. We can therefore confidently support the principals' recommendation:

3. All applicants for the preliminary year should take the Learning Potential test as an entrance examination, and selection should be on the basis of scores on this test, the possession of minimum academic qualifications, and an interview.

Possession of more than the minimum number of JSC passes does not seem to predict higher achievement, nor does the number of JSC passes per sitting add any predictability once the LP is taken into account. From Table 14, it would appear that students with 2 or 3 O-levels are likely to do well whether or not they have 5 JSC passes. Except for those with very large numbers of JSC passes, students with one O-level performed very similarly to those with no O-levels. We therefore make the following recommendation:

4. The minimum academic qualifications for entry to the preliminary course should be 5 JSC passes or 2 O-levels (GCE or CXC).

Table 21: Correlations between compulsory English and Mathematics examination grades and selected predictors, by course[a]

Predictor	Preprimary	Primary	Secondary
English examination grade			
English GCE pass	24	18	38
English entrance score	46	42	59
LP entrance score[b]	30	39	20
Mathematics examination grade			
Mathematics pass (GCE or JSC)	34	25	-
Maths. entrance score	62	51	-
LP entrance score[b]	61	31	-

[a]Decimal points omitted.

[b]Corrected for restricted range.

English and Mathematics These two subjects occupy a special place in the teachers' college curriculum: A minimum standard of communication in English is required for every college subject, English is a compulsory subject in all courses, and Mathematics is compulsory in all courses except the secondary course. It is therefore necessary to require some minimum entry standard in these two subjects in addition to any overall requirements. We now consider what the results of this study have to say about these standards.

Table 21 shows the correlations found between English and Mathematics examination performance (where the subject is compulsory) and some entrance qualifications. (Correlations with English pass (GCE or JSC) and Mathematics GCE pass were also calculated but have been omitted from the table because of their doubtful validity: few students did not have an English pass and few had a Mathematics GCE pass). Correlations with the public examination results seem to be rather low; in the best case, only 15% of the variance in Secondary English examination grades was accounted for by whether or not a student had passed GCE English before entry to college. The English and Mathematics entrance examination scores were much better predictors, but this could be at least partly because they were continuous scores whereas the public examination results were only recorded as pass/no pass. The LP score was not as good a predictor as the English and Mathematics scores, although in two out of five cases the difference was neglible.

We conclude that the possession of JSC or O-level passes in English or Mathematics is not a reliable guide to performance in these subjects in teachers' college, that the corresponding entrance examinations are likely to be better guides, and that in this respect the LP score cannot be used in place of the English and Mathematics entrance scores without loss of predictive information. It would therefore seem reasonable to use a high English or Mathematics entrance score as an alternative to possession of a JSC or O-level pass in that subject. We therefore make the following recommendations:

5. Applicants for the Diploma course who do not have JSC or O-level passes in English or (except for the Secondary course) Mathematics should take the corresponding entrance examination and only those who achieve an agreed cut-off point should be considered for entry.

6. Applicants for the preliminary course who do not have a JSC or O-level pass in English should take the English entrance examination and only those who achieve an agreed cut-off point should be considered for entry.

7. The preliminary year should include a course leading to JSC Mathematics for those who enter without any qualification in this subject and who wish to enter a Preprimary or Primary Diploma course.

The cut-off points mentioned above could be determined in such a way as to give those accepted on the basis of the entrance score the same chance of success as those accepted on the basis of a JSC or O-level pass. The cut-off point for the preliminary year could be lower than that applied for entry to the Diploma course if students who entered on that basis were required to take English during that year. Recommendation 7 is made to increase the supply of suitably qualified applicants for training as primary and preprimary teachers: in the 1976 cohort, fully one-third of the students in these courses had no mathematics qualification before entry.

Our recommendations 1-7 are similar in many respects to those made by the committee of principals, but we do not go so far in abandoning the entrance examination in its present form. What we are recommending may be seen rather as an exception system:

4 or more O-levels --- exempt from LP paper
JSC/O-level English --- exempt from English paper
JSC/O-level Mathematics --- exempt from Mathematics paper

Our purpose is to allow entry to candidates who are likely to succeed in the college programme but who might be excluded if entry is based only on number of O-levels and/or the LP entrance score. We have also proposed stricter cut-off points, stricter subject requirements for entry to the Diploma course, and the provision of further mathematics instruction in the preliminary year.

We make one last recommendation.

8. Data on the entrance qualifications and examination performance of entrants to the new programme (both the Diploma course and the preliminary year) should be collected for the first cohort after the programme has "settled in" and analysed to examine the validity of the selection procedures adopted.

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